Comment on "Magnetic Percolation and the Phase Diagram of the disordered RKKY model'

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The letter by Priour and Sarma [1] only confirms, by Monte Carlo methods, results obtained previously by us within a semi-analytical approach [2]: the fully self-consistent local Random Phase Approximation(SC-LRPA)[3]. Although very similar to their letter, we regret that our work is not quoted. However, the publication of their letter is interesting for several reasons. First, it confirms the correctness of the phase diagram of the dilute RKKY model: Figure 4 of [2] and Fig.1 of [1] are in essence identical. Additionally, as demonstrated in [2, 3] and contrary to many published statements, even those of the authors of the letter [4, 5, 6, 7], the dilute RKKY model is *not* a viable model for dilute magnetic semiconductors(DMS) because of frustrating effects which are not seen in the simplest mean field theory[6] or VCA approximations[4, 5]. Thirdly, it clearly supports the crucial points, made by us in several papers [2, 3], that the problem of these oversimplified theories is not only due to an inappropriate treament of the Heisenberg Hamiltonian (Mean Field Virtual Crystal Approximation) but also due to the invalidity of the RKKY form of magnetic couplings. Finally, on a more theoretical level, it demonstrates the accuracy of the SC-LRPA, both in the region of stable ferromagnetism, which is not surprising given the success of the calculations in the comparison with experimental results in diluted magnetic semi-conductors (and Monte Carlo results using the same *ab initio* couplings[8], but even to accurately predict instabilities due to frustration effects. Given the speed of computation (at least 3 orders of magnitude faster) this confirms, contrary to statements sometimes made, the superiority of the semi-analytical method.

Where the letter [1] falls short, is in giving a resolution to the puzzle: if RKKY *cannot* explain the ferromagnetism of DMS for physical values of carrier density, what is missing from the model approach? Are the model approaches of no use to understand ferromagnetism in diluted magnetic semiconductors? In our earlier paper[2], by examining the issue heuristically starting from two impurities, and in a more recent work[9], in terms of the dilute non perturbative J_{pd} model, we provide an answer. The physical mechanism that is missing from the perturbative-based RKKY picture, and which is present in ab-initio approaches, is that when treated non-perturbatively, the J_{pd} interactions can introduce a resonant nature to the conduction band. This gives a ferromagnetic bias to the magnetic interactions and stabilizes ferromagnetism. This is seen clearly in Figure 3 of [9] where we demonstrate that the ferromagnetism persists for much higher carrier densities and at higher temperatures than is possible in the RKKY model.

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